
memorandum**Richland Operations Office**

DATE: JAN 04 2016
REPLY TO
ATTN OF: AMRP:RFG/16-AMRP-0072
SUBJECT: 300-296 KURION REPORT: LED GAMMA RADIATION TESTING,
KUR-1782-RPT-008
TO: Memo to File

As part of design efforts for 300-296, no data could be found regarding types of lighting that would operate in high dose rate areas, such as room 133 (B-cell) of the 324 facility. The attached report provides an evaluation of commercially available light emitting diode (LED) lighting. This report failed to receive proper technical editing prior to being issued with the 60% design report for 300-296; additionally, this report is exceedingly difficult to find. The purpose of this memorandum to file is to place this report in the RL records system, as well as to place it in the Administrative Record for 300-296.

Questions on the attached can be addressed to me at any time.



R. F. Guercia, Subproject Director
D4 and 300 Area Field Remediation

Attachment

cc w/attach:
Administrative Record, 300-FF-2 OU (300-296)

KUR-1782-RPT008, REV. 0

LED GAMMA RADIATION TESTING

August 21, 2014

Prepared by:

Paul Gee

Victor Renard

Prepared for:

KURION
Isolating Waste from the Environment

1355 Columbia Park Trail
Richland, WA 99352
(509) 737-1377
www.kurion.com

This page intentionally left blank.

TABLE OF CONTENTS

1.0	SUBJECT.....	1
2.0	INTRODUCTION	1
3.0	OBJECTIVES	1
4.0	CONCLUSIONS.....	2
5.0	SUMMARY OF RESULTS	2
6.0	RECOMMENDATIONS	6
7.0	DISCUSSION	6
8.0	REFERENCES	6
9.0	INCLUDED SHEETS	7

FIGURES

FIGURE 1: Testing Set-Up Depiction	page 2
FIGURE 2: Testing Set-Up Photographs	page 3
FIGURE 3: LUX Meter	page 4
FIGURE 4: Operational Displays (during testing)	page 4

TABLES

TABLE 1: DATA	page 7
---------------	--------

TERMS

LED	light emitting diode
REC	Radiation Engineering Complex
R/hr	Rads/hour
R	Rads
RSR	Radiological Survey Record
PNNL	Pacific Northwest National Laboratory
HEF	High Energy Facility

This page intentionally left blank.

1.0 SUBJECT

This report documents an evaluation of a commercially available light emitting diode (LED) array to exposure of gamma radiation from a cobalt 60 source. The testing is being performed as a verification to ensure LED lights can be successfully used as in-cell lighting during the 300-296 Soil Remediation Projection at the Hanford Site 324 Building,.

2.0 INTRODUCTION

LED lights are under design consideration as a low voltage, long life, low heat lighting source for use during the remediation efforts within the Radiation Engineering Complex (REC) of the Hanford Site 324 building. Light fixtures utilizing LED technology provide an excellent source of light in a wide variety of form factors while using very limited quantities of power and producing very little heat. LED lights have very long life spans as compared to incandescent and compact florescent lights in standard environmental conditions. The LED light offers significant advantages in remote applications where space is limited and replacement of the lights is difficult. No published information on performance of LED lights in a high radiation environment (up to 10,000 Rads/hour (R/hr)) can be found.

LED lighting is being considered for use within all of the separated spaces/rooms of the Building 324 REC. B-Cell of the 324 REC has the lowest mounting elevation for the LED lights and therefore potentially the highest radiation exposure threshold. Radiation levels at this mounting elevation show a maximum of 180 Rads/hour (R/hr) with an average 122 R/hr from Radiological Survey Record, RSR-300PS-10-0007. Based on this, the total expected exposure can readily be predicted for the planned 6 month project life and appropriate test goals established.

Gamma radiation exposure testing will be conducted using a Cobalt-60 source at the Hanford Site 318 Building, within the Pacific Northwest National Laboratory (PNNL), High Energy Facility (HEF) and by the PNNL staff located there.

3.0 OBJECTIVES

The objective of this evaluation is to identify if the proposed LED light function will be adversely affected by gamma radiation exposure to the point of being inoperable or incapable of providing the required illumination. An accelerated exposure rate was determined to be the most effective test alternative for the project and will be accomplished by controlling the LED array distance to the Cobalt-60 source in an effort to reduce the test time through increased dose rate. Reduced distance to the source will substantially increase the radiation dose exposure per unit time of the LED array and thereby accelerate any potential gamma radiation induced failure mode(s) of the test component.

Continuous visual monitoring of the LED array via on site video cameras as well as periodic luminous output measurements using a handheld Konica Minolta LUX meter will be used to establish functional performance capability throughout testing. A performance metric of less than 35% of the start of test Lux output of the LED array was established as the ultimate failure threshold criteria for this test before initiation of any exposures.

4.0 CONCLUSIONS

Successful gamma radiation (Cobalt-60) exposure testing of Light Emitting Diode (LED) light bars was conducted in the PNNL High Energy Facility (HEF) located in Building (Bldg.) 318 of Hanford Facility on the dates of Aug. 11-12, 2014. The tested unit was a commercially available, 15 LED light bar (LEDP3W-15-F-BLK) of a common design to the 27 LED light bars intended for use in the Hanford Site 324 Building, 300-296 Soil Remediation Project.

The 15 LED light array passes the Lux output test requirement and remained functional throughout its test exposure to a total Cobalt-60 gamma radiation dose of 397,108.8 Rads (R) with a maximum dose rate of 58,363 R/hr. After 440 total minutes of test exposure for a predicted 3,255.99 equivalent hours of B-Cell gamma exposure, the 15 LED light bar was operating at an acceptable 83% Lux output level with 12 of the 15 LED's still illuminating. This testing confirms that this type of LED light bar array should be able to provide the necessary in-cell illumination required to conduct the intended project operations.

5.0 SUMMARY OF RESULTS

A 15 LED light array (LEDP3W-15-F-BLK) was exposed to a total Cobalt-60 gamma radiation dose of 397,108.8 Rads (R) over a total of 440 test minutes of exposure time on Aug. 11 and 12, 2014 in the PNNL, HEF laboratory. Reference the depiction and pictures below for testing setup.

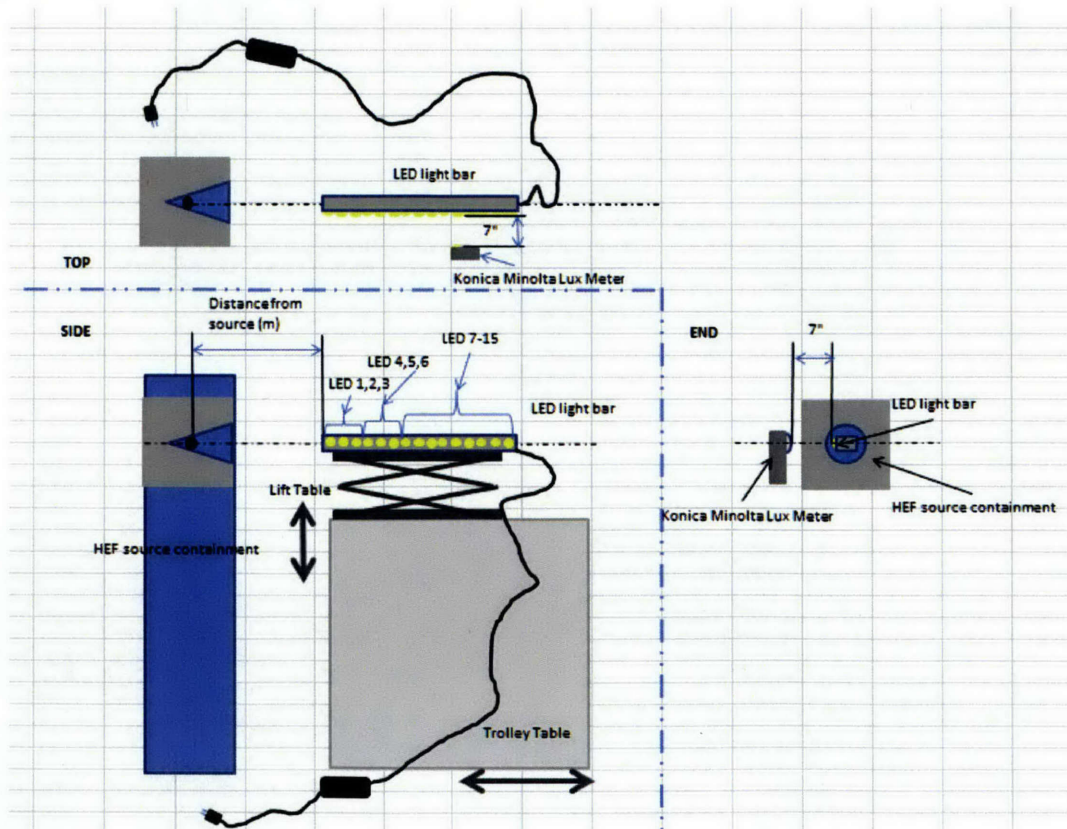


FIGURE 1: Testing Set-Up Depiction



FIGURE 2: Testing Set-Up Photographs

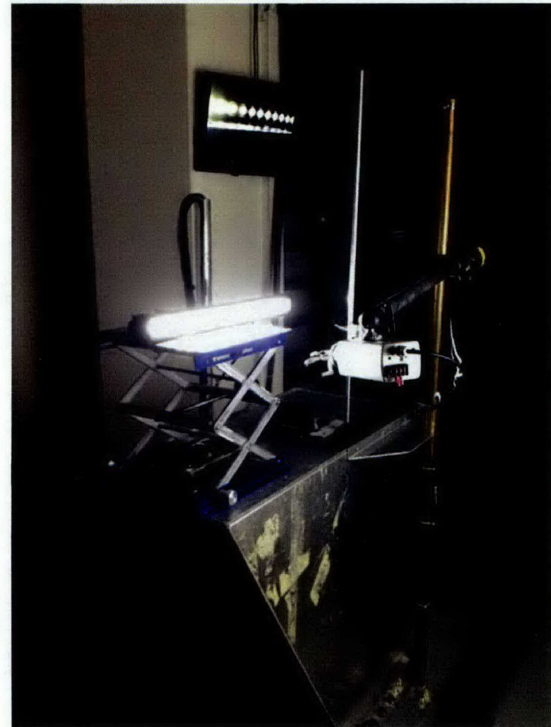
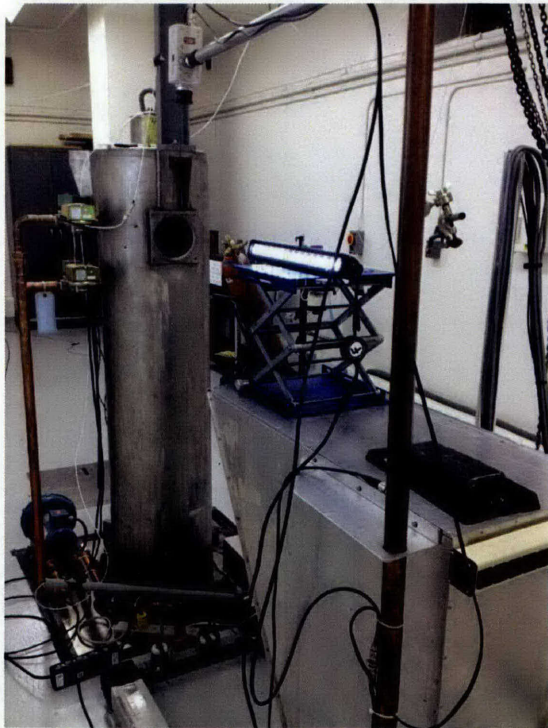




FIGURE 3: LUX Meter

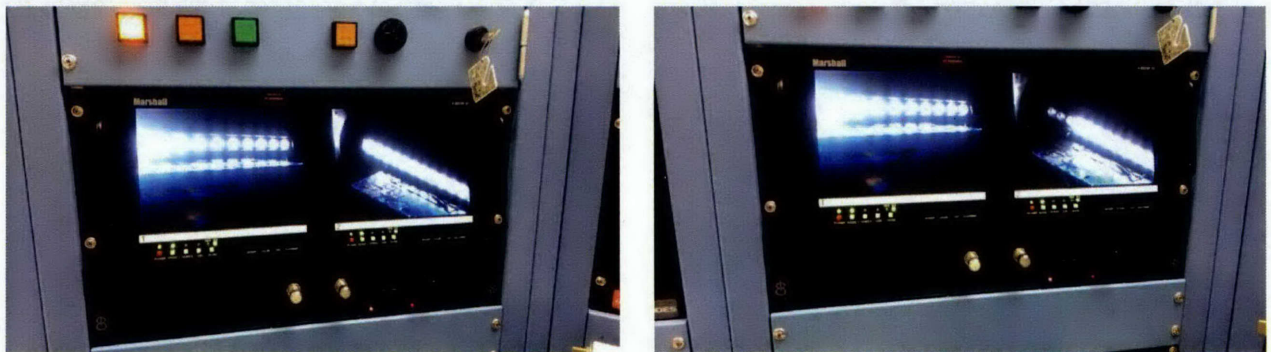


FIGURE 4: Operational Displays (during testing)

The Lux output of the light array at the start of testing measured 49,000 Lux and finished at 40,600 Lux after 440 minutes of gamma exposure time with the lowest measured output, 40,000 Lux occurring prior to any abnormal LED behavior. At the completion of testing the LED array was still functional and outputting 83% of the initial level. This passes the 35% Lux output requirement and is inclusive of unexpected fixturing variability which is believed to account for nearly 9% of the 17% output loss. The testing could have continued beyond this point but the test duration was intentionally limited as explained at the end of this report section.

Over the course of the testing the six LED lights in closest proximity to the radiation source (see above sketch depictions) all experienced intermittency of operation at various times beginning after 170 test minutes and 134,475.3 R exposure (33.9% of the total accumulated exposure) while the other nine LEDs remained in an uninterrupted state of illumination for the entire test duration. The lights of the LED array appear to be wired in groups of 3 successive lights as LEDs 1, 2, 3 all exhibited the same intermittent behavior to one another as did LEDs 4, 5, 6. After the first irregular behavior at 170 minutes each group 1, 2, 3 and 4, 5, 6 typically were intermittent independently except at one period when all six together experienced common symptoms for the duration of 19.6 minutes early on day 2 of testing.

The chronology of the testing proceeded as described below:

Testing was without incident for the first 170 minutes (134,473.3R) of exposure after which LEDs 1, 2, 3 began to show intermittent operation between full on, off and flickering phases with seemingly random intervals between each. At 258 minutes (200,074.4 R) LEDs 1, 2, 3 returned to full on along with the rest of the array, completing 260 exposure minutes (222,019.8 R) and testing for the day of Aug 11.

Testing was restarted on Aug. 12 with 260 exposure minutes logged (222,019.8 R) and LEDs 1, 2, 3 out (not illuminating) with an array output of 42,000 Lux. After an additional 20 minutes (total 241,474.1 R) LEDs 4, 5, 6 also began to flicker until 29.6 minutes into the testing (total 250,812.2 R) when all 15 LEDs regained illumination. After that period of full illumination, LEDs 1, 2, 3 and 4, 5, 6 proceeded to be randomly intermittent until the time of 382 exposure minutes (total 282,328.2 R) when LED's 1, 2, 3 returned to full illumination and stayed lit for the remainder of the test. LEDs 1, 2, 3 & 7-15 remained uninterruptedly lit from that point and LED's 4, 5, 6 continued on with random intermittency until the end of testing at 440 minutes (total 397,108.8 R) exposure. At the completion of testing LEDs 4, 5, 6 were out and the LED light bar was outputting 40,600 Lux. (Reference the attached data table in section 9 for this same summary in a data table format)

The testing duration was considered complete at 440 minutes based on the calculated gamma radiation exposure for the lowest mounted LED light locations within B-Cell. The intended LED usage location within the project facility with the highest potential dose rate is at the +5 foot elevation of the B-cell, where an average dose rate of 122R/hr exists. Using this average dose, the actual test dose of 397,108.8 R equates to an equivalent exposure period for these lights of 3,254.99 calculated hours (397,108.8 Rad/122 Rad/hr). By using an assumed operational exposure profile over the 6 month project life of 26 weeks at 5 days/week for 24 hrs/day, an operational exposure threshold of 3,120 hours was predicted (26*5*24). As such, the 3120 hours equates to 380,640 R at the 122 R/hr average rate. Testing was halted at the most convenient point when this dose exposure threshold was exceeded.

6.0 RECOMMENDATIONS

LED light bars of this design can be employed for this project in the proposed mounting locations without significant operational impact due to exposure during use even though the testing was showing signs of gamma radiation induced failure progression. This recommendation also may be improved upon by retracting the LED lights back into the wall ports when not in use so as to improve their longevity and reduce the time until irregular operational behavior occurs.

7.0 DISCUSSION

NOT USED

8.0 REFERENCES

NOT USED

9.0 INCLUDED SHEETS

TESTING RESULTS SUMMARY TABLE

DATE	TEST #	DISTANCE FROM SOURCE (m)	GAMMA EXPOSURE RATE (R/hr)	EXPOSURE MINUTES	Cuml. Minutes	Rads (calc)	Cuml. Rads	EOT LUX (meas. @ 7 in) (APPROX 2/3 FROM HIGH EXPOSURE END)	% OUTPUT	% OUTPUT acctg for refixture	NOTES
8/11/2014	0		0					0.62			start of testing before exposures, all LEDs lit
8/11/2014	1	5.25	184	15	15	46.0	46.0	49000	102%		all leds on at end of test
8/11/2014	2	2.5	1000	5	20	83.3	129.3	49500	101%		all leds on at end of test
8/11/2014	3	1	5128	5	25	427.3	556.7	49600	101%		all leds on at end of test
8/11/2014	4	0.7	10511	5	30	875.9	1432.6	49800	102%		all leds on at end of test
8/11/2014	5	0.5	20712	5	35	1726.0	3158.6	49600	101%		all leds on at end of test
8/11/2014	6	0.3	58363	5	40	4863.6	8022.2	44000	90%		fixtures was moved to set-up 0.3m distance (likely changed LUX meter positioning), all leds on at end of test
8/11/2014	7	0.3	58363	5	45	4863.6	12885.8	41600	85%	95%	all leds on at end of test
8/11/2014	8	0.3	58363	5	50	4863.6	17749.3	40900	83%	93%	all leds on at end of test
8/11/2014	9	0.3	58363	30	80	29181.5	46930.8	40000	82%	91%	all leds on at end of test
8/11/2014	10	0.3	58363	60	140	58363.0	105293.8	40400	82%	92%	all leds on at end of test
8/11/2014	11	0.3	58363	60	200	58363.0	163656.8	41300	84%	94%	at 30min in leds 1,2&3 off/on for remainder of test, at 37 min in long off time, 43min back on, 57min off continue til end
8/11/2014	12	0.3	58363	60	260	58363.0	222019.8	41400	84%	94%	leds 1,2&3 off at start of test, came on at 58min and stayed on to end, on at end when LEDs powered off
8/12/2014	13		0		260		222019.8	42000	86%	95%	start of testing before exposures day 2, LEDs 1,2,3 out/off
8/12/2014	14	0.3	58363	60	320	58363.0	280382.8	40300	82%	92%	4,5,6 went out 20min into test, all on at 29.6min into test, 4,5,6 out at 39min in and flickering on/off til 59min then all on
8/12/2014	15	0.3	58363	60	380	58363.0	338745.8	40200	82%	91%	all on to start, 2 min in 1,2,3 on 4,5,6 flickering, 1,2,3 on til end, 4,5,6 flickering til 58min then out
8/12/2014	16	0.3	58363	60	440	58363.0	397108.8	40600	83%	92%	4,5,6 off to start, 1min in all on, 2m in 4,5,6 out again til end flickering for some of the remaining time but out at 60min

TABLE 1: DATA

APPENDIX

Intentionally Blank